OTHER PEOPLE'S TOBACCO SMOKE

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"Environmental Tobacco Smoke and Coronary Heart Disease"
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7. Environmental Tobacco Smoke and Coronary Heart Disease

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1. What is coronary heart disease?

Before considering whether exposure of the non-smoker to ETS represents a health risk, let us highlight, briefly and simply, some of the basic physiology, anatomy and pathology of importance to an understanding of coronary heart disease (CHD). This type of heart disease, also known as ischaemic heart disease, has been at the centre of public health interest for 25 years because it is the leading cause of death in many countries, including the UK and the USA.

The heart is a blood-filled bag of muscle, which contracts and relaxes roughly 70 times a minute to pump blood around the body. It has a remarkable capacity to adapt its performance throughout life, according to the needs of the body, by varying its rate and strength of beat. As one of the most active tissues in the body, the heart muscle needs a good supply of oxygen to function efficiently. This supply is not obtained from the blood which is pumped through the chambers of the heart, but from blood pumped through the coronary arteries. These arteries branch off from the main artery (aorta) as it leaves the heart and they then divide into a network of smaller branches which fan out all over the surface of the heart.

Over a period of many years, the walls of the coronary arteries gradually 'fur up' with fatty deposits known as atheroma. This condition, when severe, is coronary heart disease, the clinical manifestations of which appear in two forms — angina and heart attack. If the narrowing of the coronary arteries is very gradual (as it usually is) then the first sign of trouble may only be noticed when the heart has to work harder than usual. For example, during brisk exercise, the heart muscle may fail to receive an adequate supply of oxygenated blood and chest pains (angina) may result. The symptoms are generally relieved by resting for a few minutes. A heart

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attack, on the other hand, occurs when there is a sudden and severe blockage of one of the coronary arteries, so that the blood supply to part of the heart muscle is not merely reduced, but cut off. The blockage is usually caused by a blood clot forming in an artery already severely affected by fatty atheroma and is known as a coronary thrombosis. The part of the heart muscle affected is severely damaged (myocardial infarction) causing the *prolonged* pain that is the most common symptom of a heart attack. Sometimes the blockage is so severe that the heart stops beating in a coordinated manner and circulation of blood to all the tissues of the body effectively stops. Unless the heart starts beating normally within a few minutes, the person will die.

2. What causes coronary heart disease?

Death rates from CHD vary widely from country to country. For example, in 1984 the figures for the age group 55-64 were in excess of 800 per 100,000 in Northern Ireland, Scotland and Finland and less than 100 per 100,000 in Japan. Research workers are still trying to discover exactly what it is in our everyday lives that increases the risk of heart attack and angina. It seems certain that there is no single cause; the major risk factors are usually said to be high blood pressure, high levels of cholesterol in the blood and cigarette smoking. In addition, diabetes, lack of exercise and a generally aggressive work temperament (so-called Type A behaviour) are all considered to contribute to the multifactorial atherogenic process (Kannel, 1981).

3. Active cigarette smoking and coronary heart disease

It has been reported that male cigarette smokers, but not pipe and cigar smokers, have consistently higher overall death rates than non-smokers from CHD in many, but not all, Western societies. The size of the risk is claimed to be dependent on age and daily consumption of cigarettes, being greater in men under 50 years of age than in older men. The various epidemiology studies consider mortality ratios in slightly different age ranges. For men aged 'around 50', the reported mortality ratios are some 2-3 times greater than those of non-smokers. In men aged 60 and above, however, when death from heart attacks is in any case more prevalent, the mortality ratios are consistently lower, around 1.5 (Surgeon General's Report, 1983). In female smokers, the reported association between cigarette smoking and CHD is much weaker. Several studies indicate that cigarette smoking may occasionally precipitate anginal pain in some patients or reduce exercise tolerance in others. In others, the frequency and severity of atheroma of the coronary arteries at *post mortem* were greater in smokers than in non-smokers. (For specific references, see Royal College of Physicians, Reports 1-4, on Smoking and Health, 1962, 1971, 1977, 1983.)

On an acute basis, the act of cigarette smoking causes a marked increase in heart rate, an increase in cardiac output and a relatively smaller increase in blood pressure. The effects are due to absorption of nicotine into the bloodstream, increase with degree of inhalation, and in *healthy* subjects are perfectly *normal* and *harmless*. In subjects who have already had a heart attack and suffered a myocardial infarction, however, a fall in cardiac output may occur. It follows that such subjects who can readily be identified should not smoke cigarettes (Pentecost and Shillingford, 1964).

Although the public health lobby frequently claims a causal relationship between active cigarette smoking and CHD it should not be forgotten that the disease is a common affliction among non-smokers. Furthermore, there is much evidence that is not wholly consistent with a claim of causation (Seltzer, 1980, 1981). One notable objection is lack of proof of the mechanisms by which cigarette smoking may accelerate development of CHD and precipitate death. Nicotine and carbon monoxide have been implicated at one time or another, but the reasons have been theoretical and emotional, rather than strictly factual.

The possibilities have been fully discussed by Wynder *et al.* (1976), while Cohen and Roe (1981) elegantly summarised the actions of nicotine that might play a role in cardiovascular disease. In the opinion of the present author, however, it is misleading to state that cigarette smoking, nicotine and carbon monoxide may cause CHD. A similar claim for eating is just as reasonable! After all, our restricted diet in World War II and for the rest of the 1940s had a favourable effect on CHD death statistics.

4. ETS and coronary heart disease

The foregoing summary concerning active cigarette smoking and CHD provides the basis for comparing the role of ETS. On this subject, there are relatively few relevant published data, which is reflected in the fact that cardiovascular diseases occupied only two of the 359 pages of the recent Surgeon General's report, *The Health Consequences of Involuntary Smoking* (1986), and did not feature in any of the 16 paragraphs concerned with exposure to ETS of the 4th Report of the Independent Committee on Smoking and Health (1988).

5. Dosimetry

The concentration of ETS to which an individual is exposed depends on:

- Type and number of cigarettes burned
- Volume of room
- Ventilation rate
- Proximity of burning cigarette

The effective dose for an exposed individual is the dynamic integration of concentration in various environments and the time the individual spends in

these environments. These considerations highlight the difficulty of assessing accurate dosage under 'real life' conditions, which is one major weakness of most, if not all, ETS epidemiology studies. It is possible to measure the concentration of specific components in ETS, and the two most common marker substances are nicotine and carbon monoxide. In a recent study (Kirk *et al.*, 1988), large differences were shown to exist according to the environmental circumstances — for example, travel, leisure, work, home. The concentration of nicotine varied from non-detectable to a maximum of the order of 400 micrograms per cubic metre (mean approximately 15 micrograms per cubic metre); for carbon monoxide the range was 0-30 parts per million with a mean concentration of around 2.5 parts per million. With an individual exposed to ETS, there is normal breathing of diluted sidestream smoke (SS) and exhaled mainstream smoke (MS) from active smokers. This contrasts with the situation obtaining for the active cigarette smoker, who takes a puff of neat smoke into the mouth and then inhales it. Under these circumstances, the concentration of nicotine and carbon monoxide to which the alveolar membranes of the lung are exposed is of a totally different order of magnitude — perhaps as much as 1000 times. On theoretical consideration, therefore, the dice are heavily loaded against significant absorption of nicotine and carbon monoxide, and indeed any other putative cardiovascular toxins like nitrogen dioxide.

The theory is borne out in practice because cotinine levels in blood, saliva and urine, which are often used as a measurement of nicotine absorption of non-smokers exposed to ETS, are approximately 1% of those measured in active smokers (Jarvis *et al.*, 1984). Blood carboxyhaemoglobin levels (COHb) have been measured in non-smokers exposed to ETS under real life and artifically exaggerated conditions. They were generally in the range 1-1.5% under realistic exposure conditions.

6. Effect of ETS exposure on heart rate of healthy subjects

Normal healthy subjects exposed to ETS for periods up to two hours under resting or exercise conditions have been studied. There were no significant changes in heart rate or blood pressure in adult men and women, indicative of the absorption of negligible amounts of nicotine (National Research Council, 1986).

7. Effect of ETS exposure on heart rate of angina patients

Various studies, conducted mainly by Aronow and colleagues, have demonstrated that exercise-induced angina develops more rapidly in patients diagnosed with classic stable angina pectoris exposed to 50 parts per million carbon monoxide for periods from 1-4 hours. These concentrations are on the high side compared with those measured by Kirk *et al.* (1988) and measured levels of COHb were in fact in the range 2-4%. Only one

experiment on the effects of ETS exposure has been reported (Aronow, 1978) in which 10 patients were exposed to other people's smoke (15 cigarettes) in a small room during two hours. Even under good conditions of ventilation, when the mean carboxyhaemoglobin level was only 1.77%, there was an apparent substantial reduction in the duration of exercise until the onset of pain. The results of this experiment are questionable because the study was not conducted on a strict double blind basis, the measured end point was a subjective one, and furthermore, the validity of Aronow's work has been critically questioned (Budiansky, 1983).

8. Chronic effects of ETS exposure

Because of the many factors that play a role in the development of fatal CHD, epidemiology studies need to be carefully designed and, in addition, need to use elaborate, and appropriate, statistical techniques if they are to provide unequivocal results. This is particularly true of studies concerned with effects of ETS on non-smokers, where, based on dosimetry considerations which have already been discussed, any effects might be expected to be small. Last, but not least, the question of misclassification of smoking status, to which detailed reference has been made in the lung

Table 1 ETS and CHD — Epidemiology Studies

Author	Subjects	Major Disease Interest	Adverse effect on CHD	All risk factors adequately covered
Gillis *et al.* 1984)	Non-smoking women	Lung cancer	Yes, but sample size was small	No
Hirayama (1984,1985)	Non-smoking women	Lung cancer	Yes, relative risk 1.3 for husbands smoking more than 19 cigarettes/day	No
Garland *et al.* (1985)	Non-smoking women	CHD	Yes, but questionable statistically	No
Svendsen (1985)	Non-smoking men	CHD	NS	? not much information given
Lee *et al.* (1986)	Non-smoking women	Various	No	Yes

NS = not significant

cancer chapter, has not been considered in any CHD/ETS study apart from the case control study of Lee *et al.* (1986). This factor is as relevant to CHD as it is to lung cancer.

Rather than record the detailed numerical findings of the various studies that have been conducted, I will summarise the authors' conclusions (Table 1).

It is clear that the evidence for a harmful effect of ETS in enhancing CHD risk in non-smokers is not very convincing, as the US National Research Council also concluded in the following statement:

> 'With respect to chronic cardiovascular morbidity and mortality, although biologically plausible, there is no evidence of statistically significant effects due to ETS exposure, apart from the study of Hirayama in Japan.'

There are now, however, two reasons to cast doubt on the Hirayama data. Misclassification of smoking status almost certainly accentuates the apparent risk, even if it does not altogether explain it. Secondly, when he reported on the first 14 years of his prospective study in 1981, there was no mention of a higher mortality rate from CHD of non-smoking women married to smokers. It is difficult to believe that a previously unsuspected risk could become apparent merely as a consequence of 3 more years of follow-up. Any author is entitled to his opinions, but in the public health area there is a danger that if such opinions are reiterated sufficiently often, they may ultimately become accepted as facts. Lee *et al.* (1986), having considered all the available evidence, concluded that any effect of ETS exposure on risk of any of the major diseases that have been associated with active smoking is at most small, and may not exist. The case for exposure to ETS carrying any increased risk of death from CHD is the weakest of all. It has already been pointed out that in many studies the association between active cigarette smoking and CHD is much weaker in female smokers than in male smokers, or even non-existent. If an effect of smoking on the development of CHD cannot be convincingly demonstrated in female active smokers, it is difficult to assume that such an effect is possible in females exposed to ETS (Schievelbein and Richter, 1984) unless there is something particularly noxious in ETS, about which we are currently unaware. This seems unlikely.

At a recent meeting in Montreal, Wexler (1990) and a discussion panel also concluded that currently there is no clear demonstration of any increased risk of cardiovascular disease from exposure to ETS.

There is another and independent piece of evidence that casts doubt on any significant role of ETS in the development of CHD. Pipe smokers inhale tobacco smoke both actively, to a limited extent, and passively. They commonly surround themselves in a cloud of tobacco smoke, so that they are probably exposed to the highest concentrations of ETS of any group. Yet they enjoy relative immunity from the three major diseases which have

been associated with active smoking. In conclusion, therefore, non-smokers would be much better advised to watch their weight, diet and blood pressure than to worry about any long-term harmful cardiovascular effects of exposure to ETS!

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